Effects of Added Boar Taint Substances (Skatole and Androstenone) on the Sensory Quality of Pork

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Summary

Meat samples with known levels of androstenone and skatole were used for sensory evaluation by trained panel and were characterized with an AlphaMOS Fox 4000 electronic nose. In case of skatole women tended to be more sensitive than men. In contrast, for androstenone the sensitivity was independent of sex. Results obtained with PanelCheck V.1.3.2. software show that the panellists were more sensitive to the samples with both substances, than the samples with only androstenone or skatole. Discriminant Factor Analysis (DFA) model classification based on electronic nose sensory data shows 100% correct classiffication of the samples with only androstenone and only skatole. With using of all samples except control samples in development of discriminant analysis (DF) model, three groups were classified with 80% success: only androstenone, only skatole and the different combination of androstenone and skatole levels. Groups with slight or definite odour were classified successfully with discriminant analysis based on data obtained with two characteristic sensors (81.3% in cross validation). The preliminary results reported in this paper show that measurements of compounds with an AlphaMOS device might be a useful technique for boar taint evaluation.

Key words

boar taint, skatole, androstenone, electronic nose, sensory panel

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Aim

There is an emerging challange in pig production, since an agreement has been reached in the EU to stop castrating without anaesthesia by 1st January 2012 - and a total ban has been scheduled to be implemented by 2018 at the latest. However, it is well known that meat of uncastrated male pigs have special, abnormal odour called boar taint. Two compounds are mainly responsible for boar taint in pork from entire males. Androstenone (5α-androst-16-ene-3-one) is a testicular steroid with a definite urinary odour (Patterson, 1968). Skatole is a product of the bacterial degradation of the amino acid tryptophan in the gut and it exhibits an intense faecal odour (Vold, 1970; Walstra and Maarse, 1970). Both of these compounds become deposited in the fat and are released during cooking. Androstenone and skatole concentrations do not always match the sensory perception of taint so that the concentrations of these compounds are unreliable as an indicator of consumer response. In the last two decades the techniques based on electronic sensors, in particular the electronic nose gains more and more application possibilities in food technology and analytics. Its application may be reasoned by the determination whether food samples are identical or different; it can also be applied to predict food quality characteristics as based on the raw material quality (Hansen et al., 2005). Only few results are available regarding the evaluation of boar taint. In one of the first investigations Bourrounet et al. (1995) tested a sensor array of five MOS. Some years later Annor-Frempong et al. (1998) applied electronic-nose based on semi-conductive polymer sensors, within different odour concentrations, coupled with panel test. Ampuero and Bee (2006) calibrated the MOS based e-nose measurements with GC-MS technology. Vestergaard et al. (2006) tested e-nose equipment based on ion mobility spectroscopy, and classified androstenone and skatole samples accurately with a limit value of 0.50 μg/g and 0.21 μg/g, respectively.

The aim of the present study was to develop an objective method of identifying tainted samples using an electronic nose and sensory evaluation by trained panel.

Material and methods

Preparation of test sample and sensory procedure

A ten-member trained sensory panel (five females, five males) was used to develop the boar taint odour in meat samples. 5 g of homogenised pork meat was placed in 100 ml glass tubes and spiked with varying levels of either synthetic androstenone or skatole or both of them.

Three concentrations were carried out for both substances: andostenone (low androstenone (LA):0.25 μg/g, medium androstenone (MA): 0.75 μg/g, high androstenone (HA): 1.5 μg/g) and skatole (low skatole (LS): 0.05 μg/g, medium skatole (MS): 0.15μg/g, high skatole (HS): >0.3 μg/g). Additionally, nine different combinations of androstenone and skatole levels were used for the investigation of mixed odour. Thus, with one control (free of additional odour substances), six single odoured and nine mixed odoured samples, altogether 16 different types of meats were tested. Panel members were each presented with randomly ordered set of four blind-coded samples in each session. The samples were heated in microwave at 600 W for 30 seconds. The panellist were allowed to make repeated short sniffs, after leaving sniff bottles to stand for at least three minutes. They were then required to rate the taint status of samples as abnormal odour intensity on 100 mm line scales. Two sessions were done in a day with 20 minutes between sessions.

Preparation of test sample and e-nose procedure

The above concentrations of odour substances were added to 1 g of homogenised pork meat samples, which were placed into 20 cm³ bottles. Analysis was performed on an AlphaMOS FOX 4000 electronic nose, with 18 metal oxid cross selective sensors (MOS) in three sensor chambers. The P and T type sensors are based on SnO_2, while the LY types are of a chromium-titanium oxid basis, the n subtype with a wolfram oxid coating. The volatile compound sampling was performed with a static head space method, under tempered conditions, with automatic sampling, with the following settings: injection volume: 1500 μl; injection speed: 500 μl/s; incubation time: 500 s; incubation temperature: 95°C, acquisition time: 120 s; acquisition delay: 1080 s; flow: 150 ml/min.

The clean air supply was performed via a TOC (total organic compound) generator.

Biometric analysis

The questionnaires were evaluated by the PanelCheck V.1.3.2. software using Principal Component Analysis (PCA) on different types of consensus (averages across assessors and replicates). Sample populations were discriminated with the Alpha Soft V.12. software and the SPSS 16. software package. Discriminant Analysis (DA), Discriminant Factor Analysis (DFA), and PCA were performed to identify different samples. The reliability of the discrimination was characterized by the validation values, which are higher when sample groups are further from each other and when identical samples within the same group gather more expressedly during the classification.

Results and discussion

Sensory evaluation

The results of the evaluation of the sensitivity of perception are given for the two substances in Table 1. Women are more likely to be sensitive to the odour than are men. In case of skatole women tended to be more sensitive than men. In contrast, for androstenone the sensitivity was independent of sex.

Table 1. Influence of sex on the sensitivity of perception for the two substances.

	N	Minimum	Maximum	Mean	Std. Deviation
Abnormal odour	16	3.24	7.04	4.95	1.16
females	16	2.57	8.24	5.45	1.50
males	16	2.44	5.84	4.46	1.15
Androstenone	16	2.26	5.12	3.50	0.98
females	16	1.16	6.00	3.51	1.57
males	16	1.70	5.00	3.49	1.01
Skatole	16	1.80	5.38	3.17	1.08
females	16	1.14	5.82	3.58	1.28
males	16	0.94	4.94	2.76	1.26
Valid N (listwise)	16				

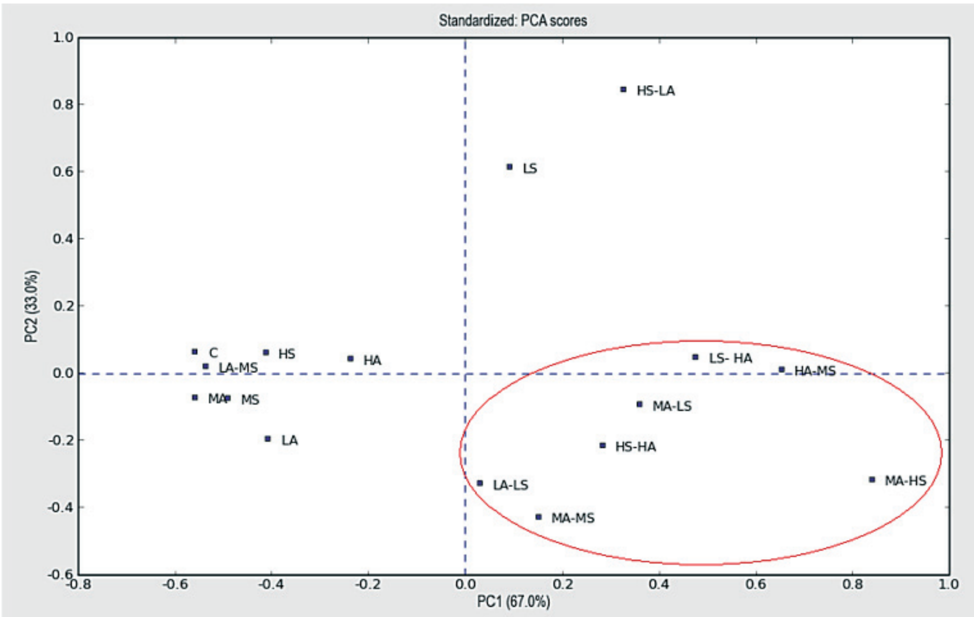

Figure 1.
Results of sensory panel test with indication of group of samples with both odour substances (C: control, LA: low androstenone, MA: medium androstenone, HA: high androstenone, LS: low skatole, MS: medium skatole, HS: high skatole, and the different combinations)

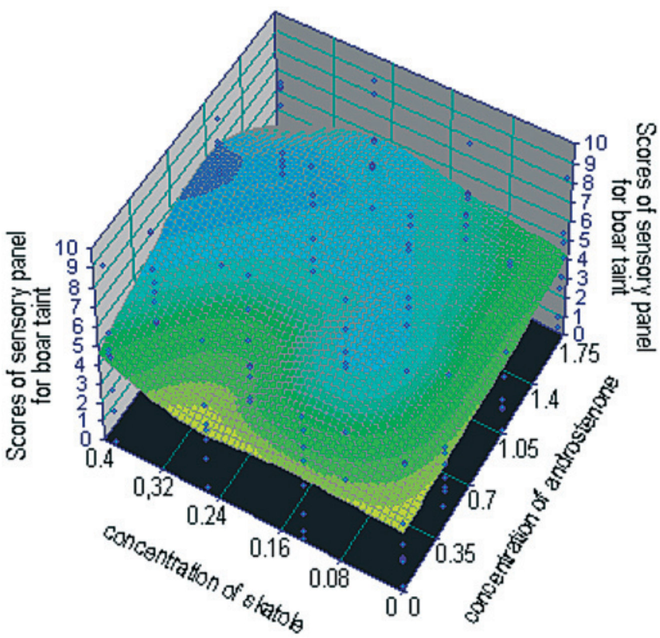

Figure 2. 3D graph of human panel sensory boar taint scores in function of androstenone and skatole concentrations

Results obtained with PanelCheck V.1.3.2. software show that the panellists were more sensitive to the samples with both substances, than the samples with only androstenone or skatole (Figure 1).

Three response classes were constructed: normal, doubtful and abnormal according to the androstenone and skatole acceptability treshold values using the aprroximation of Annor-Frempong et al. (1997). Figure 2 shows the 3D graph of the human sensory panel scores in function of the odour substances. The high peak in the front of the graph indicates clearly that the human perception gave surprisingly high values for boar taint at the samples that contained two substances in mid concentration.

Discrimination and classification of meat samples by electronic nose

In the first step DF analysis was performed for the discrimination of the samples including only androstenone or skatole (Figure 3). DFA model classification based on electronic nose sensory data shows 100% correct classification. The ratio of correctly classified samples during cross-validated was 83.3%.

With using of all samples except control samples in development of discriminant analysis model, three groups were classified with 80% of success: only androstenone, only skatole and the different combination of androstenone and skatole levels. According to the DFA in the two-dimensional plane determined by the first two factors, the sample populations of androstenone and mixed (i.e. A+S) were overlapping (Figure 4).

Relationship between panel and electronic nose responses to boar taint

The average value for abnormal odour was 4.95 during the sensory panel test. Below this value, group with slight odour was marked by 1, group with definite odour - above the average value - was marked by 2. Two solutions were applied during the development of discriminator model to identify these two groups. At first, data of all sensors were involved, which gave unacceptable results. Secondly, two characteristic sensors (LY2/LG, LY2/G) were chosen by the stepwise optimization method of SPSS, and only these were involved in classification. Discriminant analysis was run based on the values obtained with these two sensors.

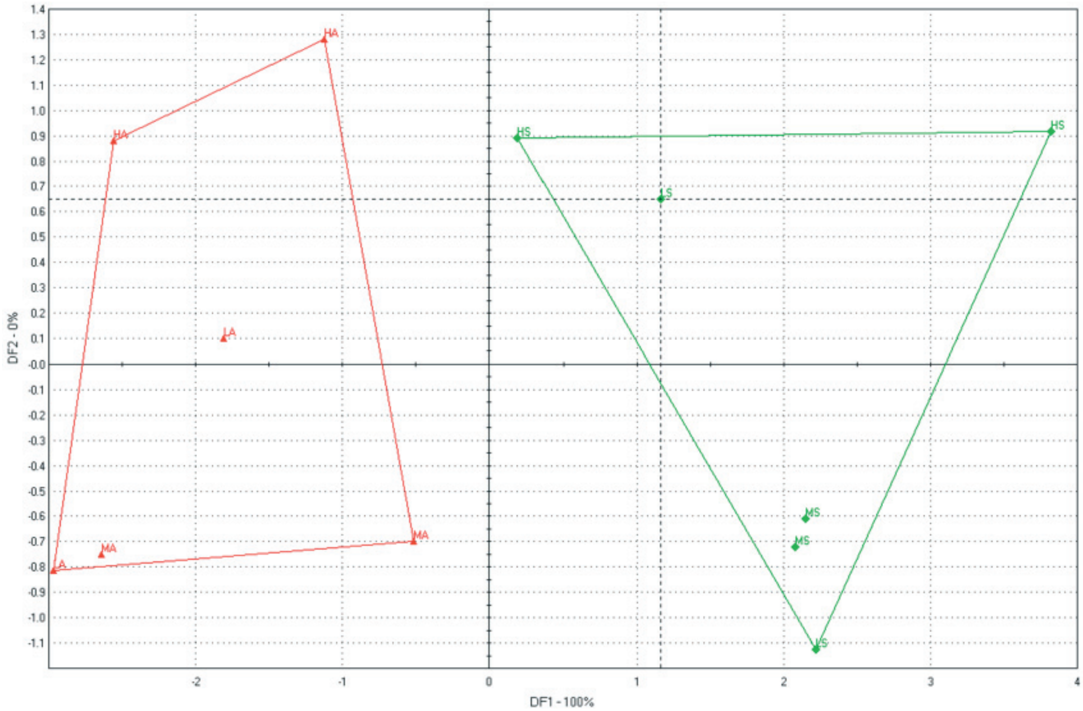

Figure 3. The discrimination of the androstenone and skatole sample populations determined by the 1st and 2nd discriminant factor

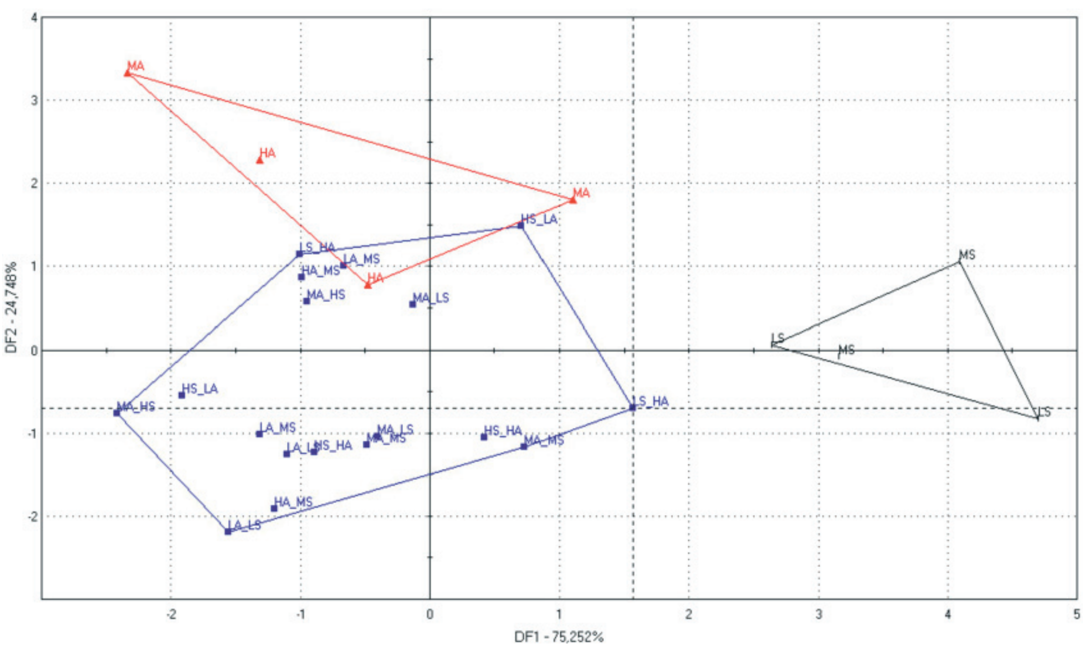

Figure 4. Overlapping of the androstenone sample and the different combination of androstenone and skatole levels

Classification of groups 1 or 2 was 87.5%, while cross-validation resulted with 81.3% success in identification of groups (Table 2).

Conclusions

In the frame of our research, a method was developed for the discrimination of samples with artificial boar taint.

For that purpose, meat samples with known levels of androstenone and skatole were used for sensory evaluation by trained panel and electronic nose. Samples containing androstenone and skatole were effectively discriminated with the electronic nose. Samples with the two substances were discriminated also by trained panel test persons. In accordance with the literature, women were more sensitive towards boar taint.

Preliminary results reported in this paper show that measurement of compounds with an electronic nose device might be a useful technique for boar taint evaluation. Further studies are necessary before practical use.

Table 2. Result chart of Discriminant Analysis for separation of groups with slight or definite odour

		Groups	1	2	Total
Original	Count	1	7	1	8
	Count	2	1	7	8
	%	1	87.5	12.5	100
	%	2	12.5	87.5	100
Cross-validated	Count	1	6	2	8
	Count	2	1	7	8
	%	1	75	25	100
	%	2	12.5	87.5	100

group 1: slight odour; group 2: definite odour

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